USCG Cutter Connectivity Bandwidth Model

US Coast Guard R&D Center

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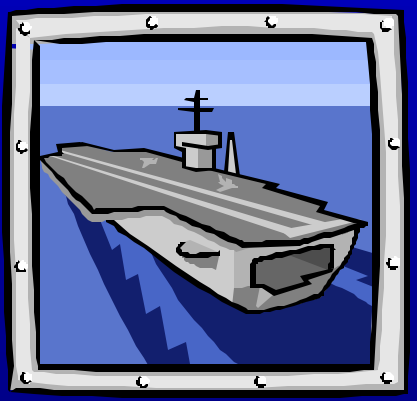
Background

- Cutter Connectivity Business Solutions Team (C2BST)
  - Look at current state of cutter data connectivity
  - Identify solutions
  - Recommend a way ahead to achieve e-CG
    - REF: “Cutter Connectivity Solutions: Coast Guard’s Best Opportunity for Cuter Connectivity and Realization of e-CG for the Cutter Fleet”(June 2001)
- Navy’s Bandwidth Study
  - Part of Surface Combatant C4I Requirements Analysis (Aug99-Mar00).

Navy Findings

- Users will fill ALL the capacity that is fielded, but *how much is enough?*
- HF and MILSATCOM will not be enough; must rely on commercial SATCOM.
- Importance of morale email, etc.

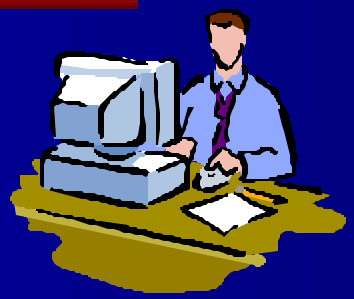


- "The young sailors and JOs of 2010 have always had unlimited internet access, cell phones, 200 channels of TV, & family contact…Today's decision makers haven't."

Problem Statement

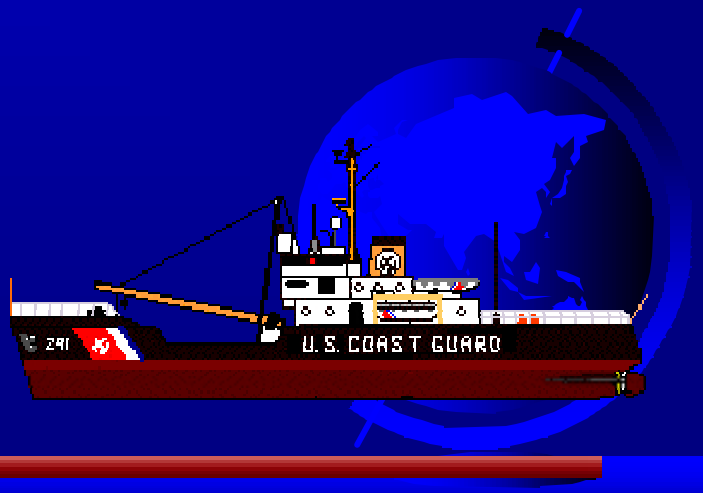
- Cutter fleet is demanding more bandwidth, but requirements aren't *quantified*.
- Can't measure existing gaps…or predict what gaps we will face in the future!

Desired End State = e-Coast Guard



A Coast Guard where…

- “IT” makes work easier, more efficient
- All members can go online anytime, anywhere
- Web-based applications
- External customers can access CG services and info



Proposed Solution

- Conduct an “Aggregate Bandwidth Study” (ABS) to baseline existing and future requirements.
- Results will be used by decision-makers to measure & predict connectivity gaps, identify potential solutions, and ask for appropriate funding.

Product Definition

- Product will be a dynamic model used to predict aggregate bandwidth usage.
- Inputs can be modified based on cutter class and mission.
- Assumptions can be modified to produce revised aggregations. (“what if” scenarios)

Scope

- Cutters are divided into two groups
  - Underway >week
  - Underway <week
- Bandwidth is defined as throughput in kilobits per second (kbps).
- Cutter data requirements derived from C4I plan, e-CG mission statement, subject matter experts, & C2BST findings.
  - USCG Enterprise Applications
  - Email, Web-browsing

Cutter Data Requirements

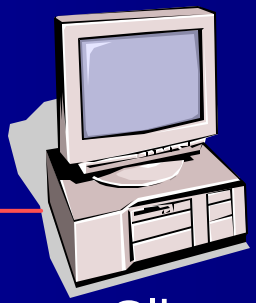
Enterprise Application	>wk	<wk
AOPS – Abstract of Operations	✓	✓
ATONIS – Aids to Navigation Info System		✓
AAPS – Automated Aid Positioning System		✓
CGHRMS – CG Human Resource Management	✓	✓
CGMS – CG Message System	✓	✓
CMPlus – Configuration Management	✓	✓
LUFS – Large Unit Financial System	✓	✓
MISLE – Maritime Information for Safety & LE	✓	✓
UTS – Unit Travel System	✓	
File Transfer (i.e. virus software updates)	✓	✓

…Plus email, web-browsing

Approach

- Use OPNET's Application Characterization Environment (ACE) module to gather explicit data
- Use OPNET IT Guru to model link between underway cutters and CGDN+.

ACE Testbed Setup



Client running OPcapture

10/100 Switch

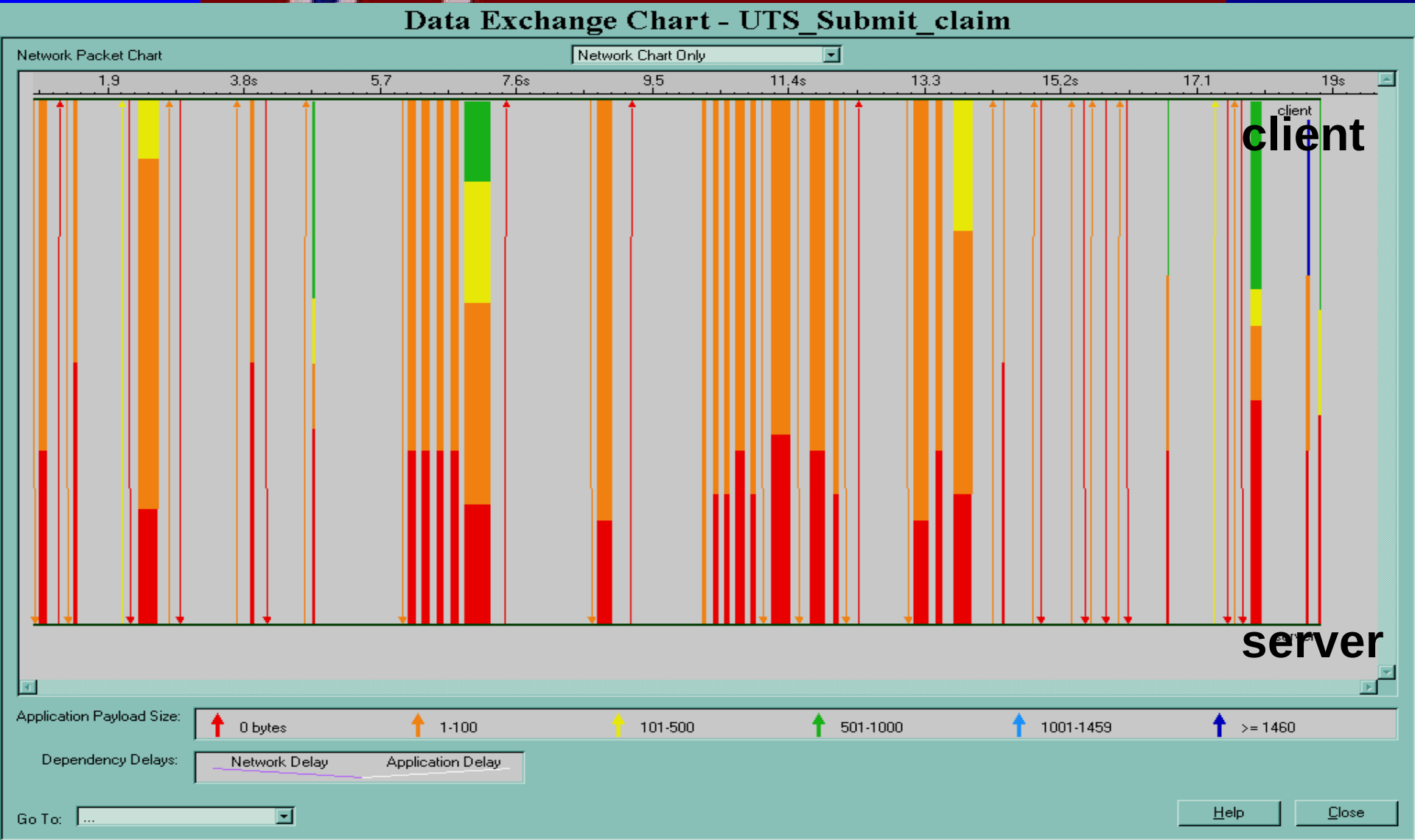
Mirrored port ➡

CGDN+

Laptop running ACE and OPcapture

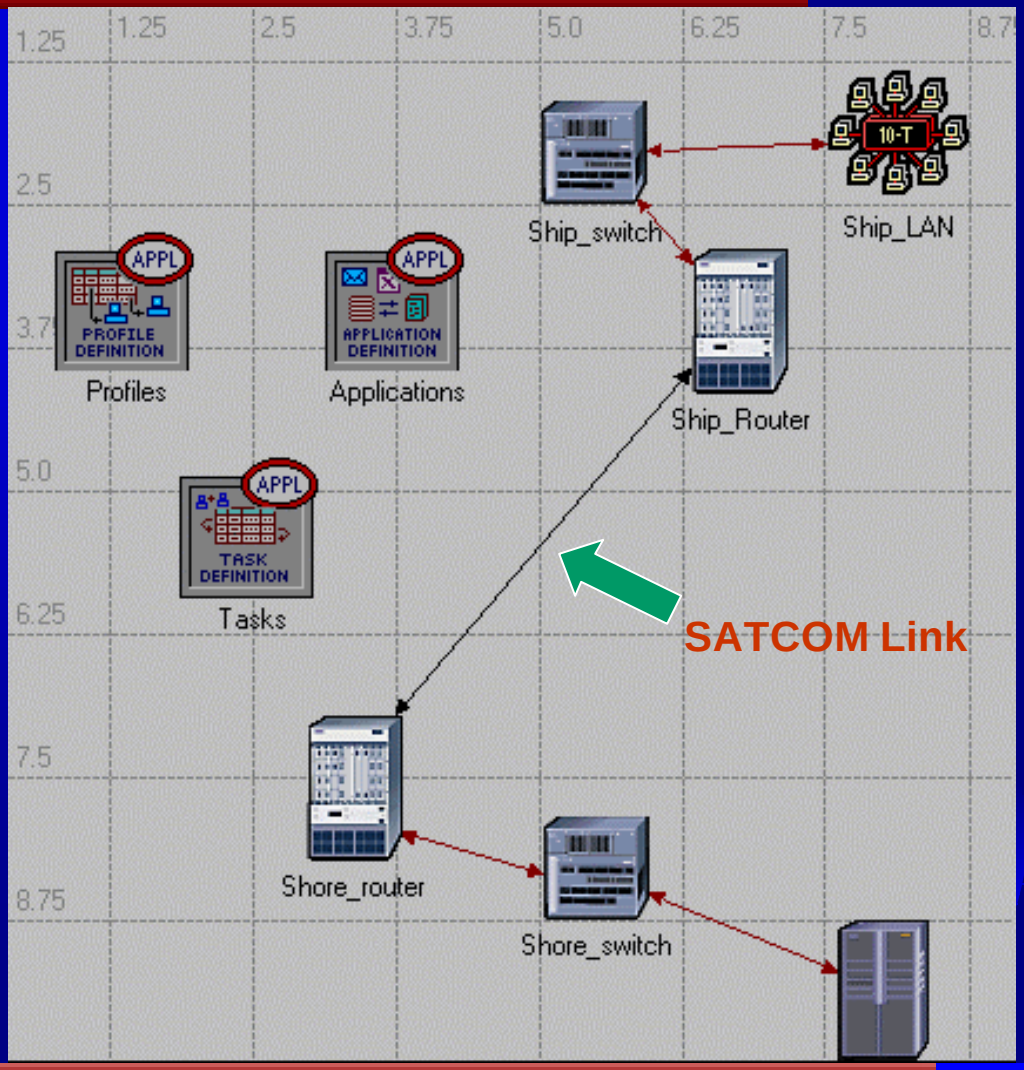
Server

ACE Trace File



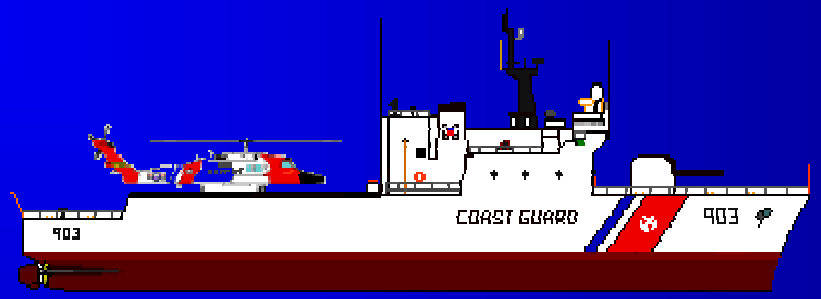
IT GURU Network Model

- Create custom-built or generic apps
- Conduct “What-if” scenarios



OPNET
Optimum Network Performance

Scenario 1: Large Cutter



- AOPS
- CGHRMS
- CGMS
- Email
- LUFS Metaframe
- CMPlus/FLS
- MISLE
- UTS
- Email & Browsing
- Virus Software update

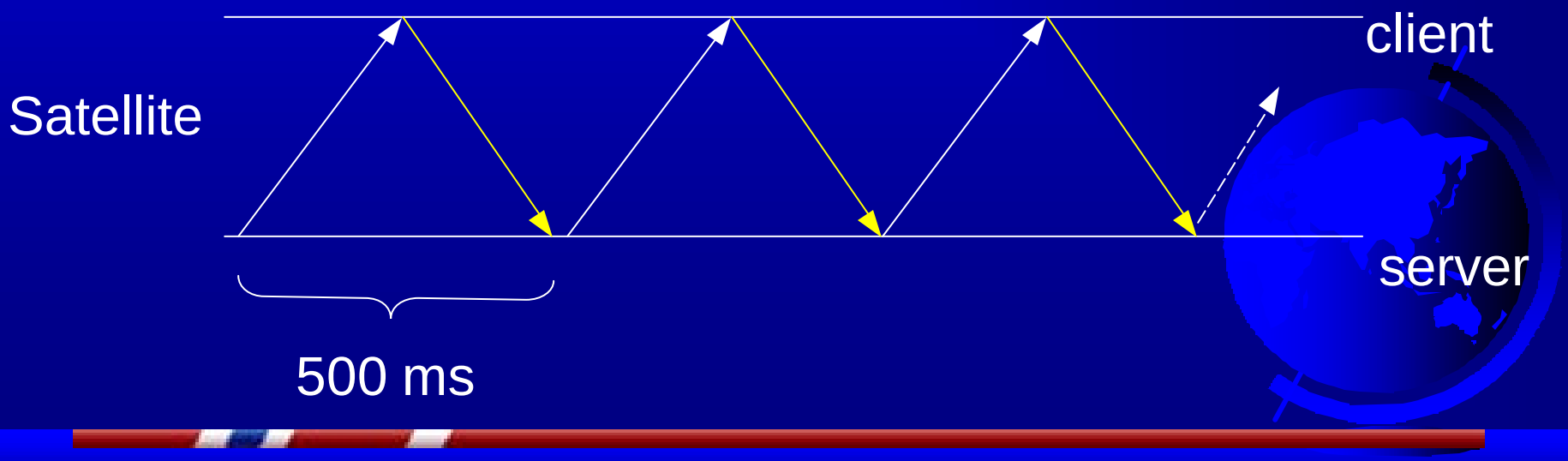
Results

Link		Throughput (bps)		Utilization (%)	
		Avg	Max	Avg	Max
T1	Ship to Shore	1542	9326	0.10	0.60
	Shore to Ship	5592	28360	0.36	1.84
64K SAT	Ship to Shore	1285	7890	2.01	12.3
	Shore to Ship	4686	22001	7.34	34.4

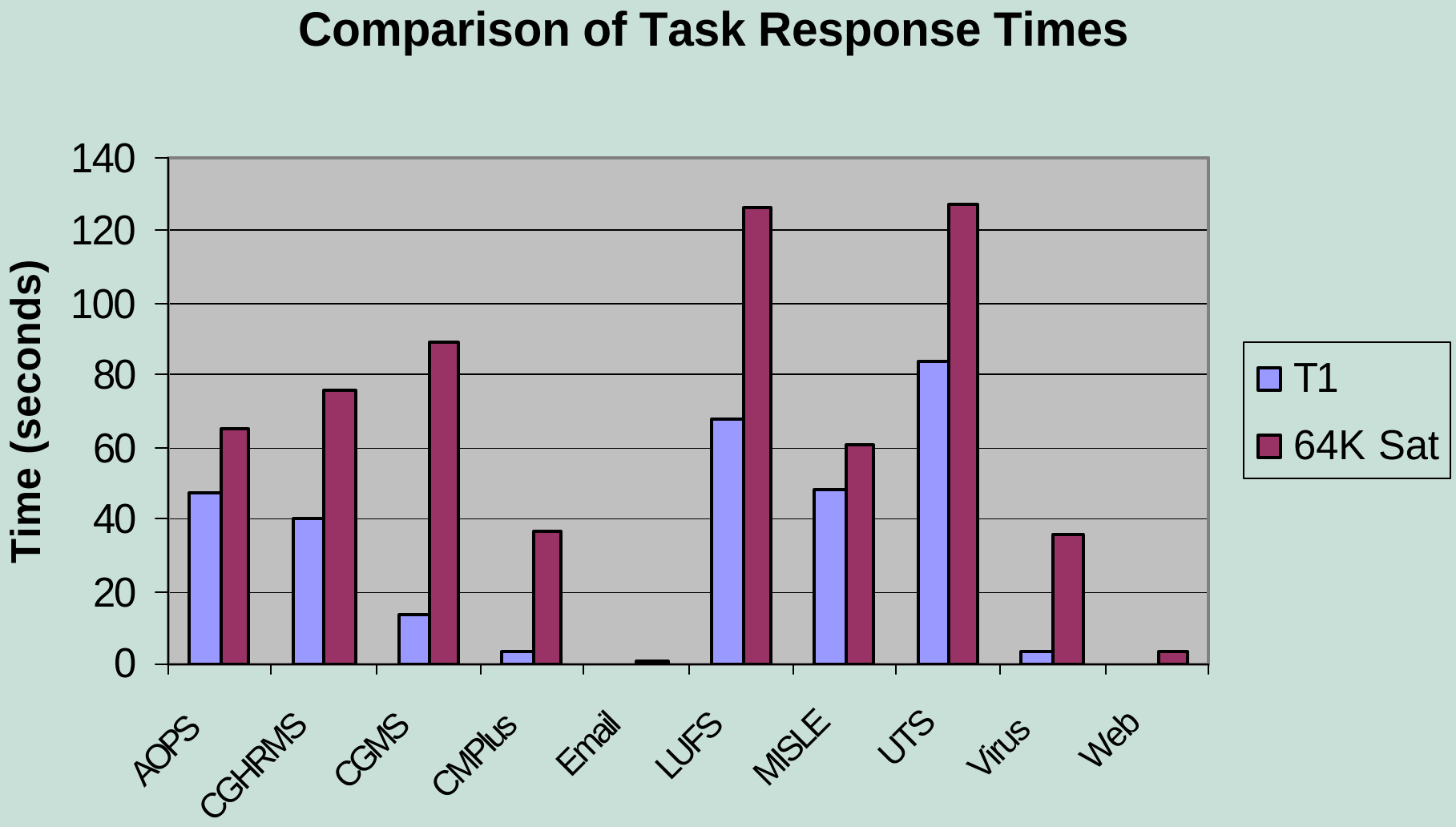
Slow Response Times = Unhappy Users

Average Response Times for App Session(sec)			
Application	**T1 Link**	**64K SAT**	**% increase**
AOPS	47.7	65.3	**37%**
CGHRMS	40.5	76.2	**88%**
CGMS	13.3	89.3	**573%**
CMPlus	3.2	36.5	**1038%**
Email	0.02	0.65	**3289%**
LUFS	67.7	126.3	**87%**
MISLE	47.8	60.4	**26%**
UTS	84.1	127.6	**52%**
Virus Updates	3.2	36.1	**1026%**
Web Browsing	0.22	3.8	**1643%**

High Latency Link



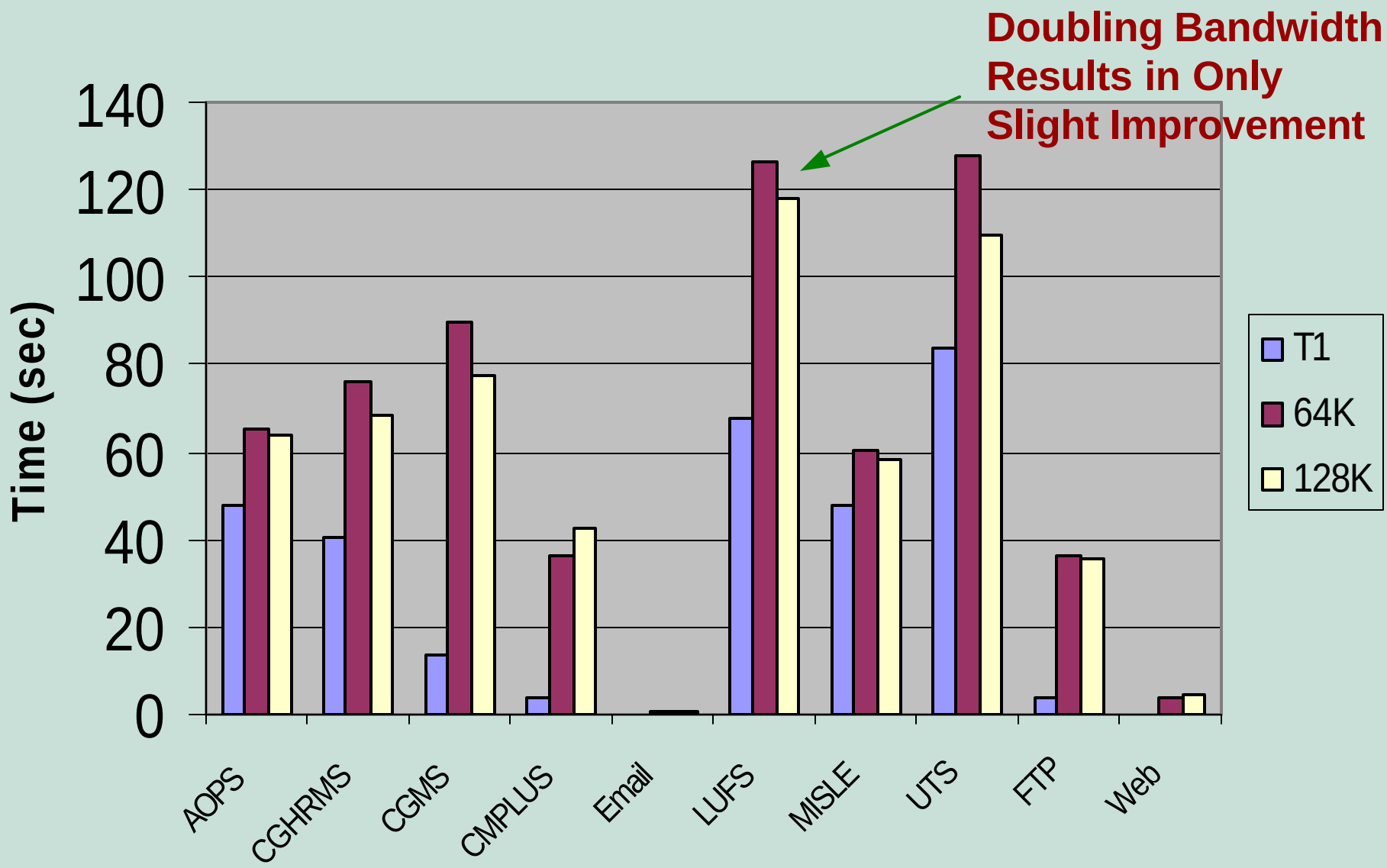
Sluggish Apps



How Do We Fix It?

- Add more Bandwidth?????

Task Response Times



How Do We *Really* Fix It?

- Reduce Latency Due to Propagation Delay
- Optimize Applications for High-Latency Link
- Improve TCP performance

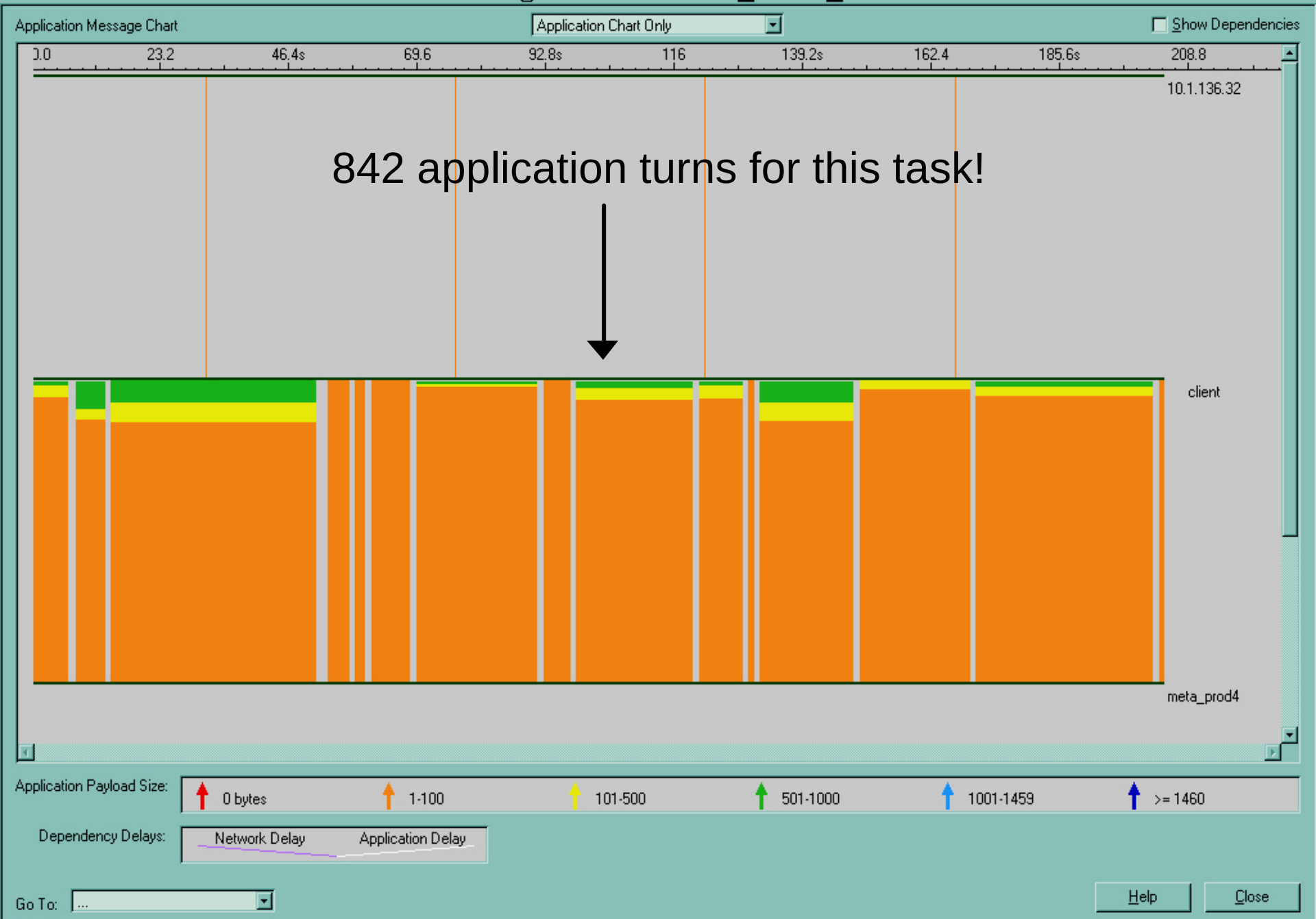
Reduce Latency

- Use Low-Earth-Orbit (LEO) system such as Teledesic.
  - Not commercially available yet
  - Not practical, because we already have Inmarsat B

Optimize Applications

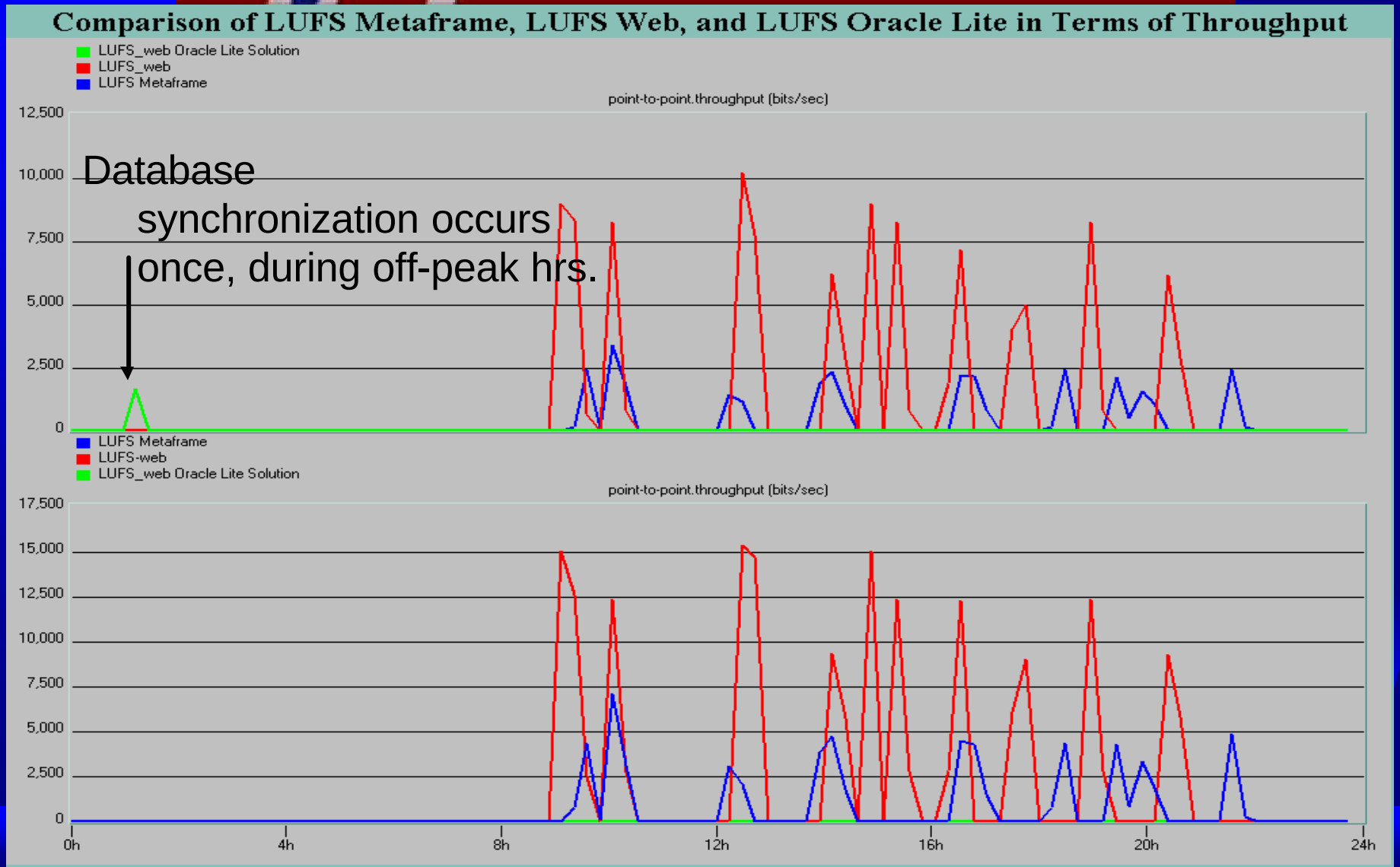
- Goal is to reduce the number of “application turns” thereby decreasing the adverse affects of propagation delay.
- Used Quick Recode to show how reduced number of application turns could help for “chatty” apps.

Data Exchange Chart - LUFS_client_createPR



Impact of Chattiness on Response Time for Creating a PR in LUFS

Case Study: LUFS



Improve TCP

- R&D Center phase II SBIR to create “tunable” TCP/IP stack
  - Optimized for satellite Link
    - Proxy on both sides enables push/pull
    - Adjustments to TCP slow start algorithm and window size, etc.
- At high-latency, TCP improvements will only improve case of large file transfer (i.e. ftp, database synch)

Scenario 2: Small Cutter

- AOPS
- CGHRMS
- CGMS
- Email
- LUFS
- CMPlus
- MISLE
- IATONIS
- Email & Light Browsing
- Virus Software Update

Results

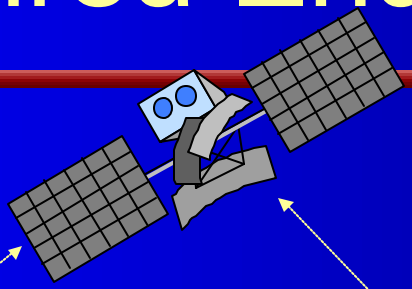
Link		Throughput (bps)		Utilization (%)	
		Avg	Max	Avg	Max
T1	Ship to Shore	1000	15118	.07%	.98%
	Shore to Ship	3571	19233	.23%	1.3%

Could we use a 9600bps LEO system?

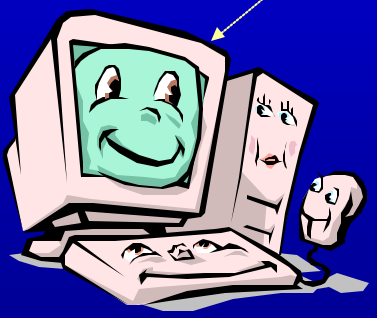
Follow-on

- Will commercial SATCOM industry be able to provide required capacity?
- Will ships be equipped to use available bandwidth?
- Are there new technology investments, which should be pursued?

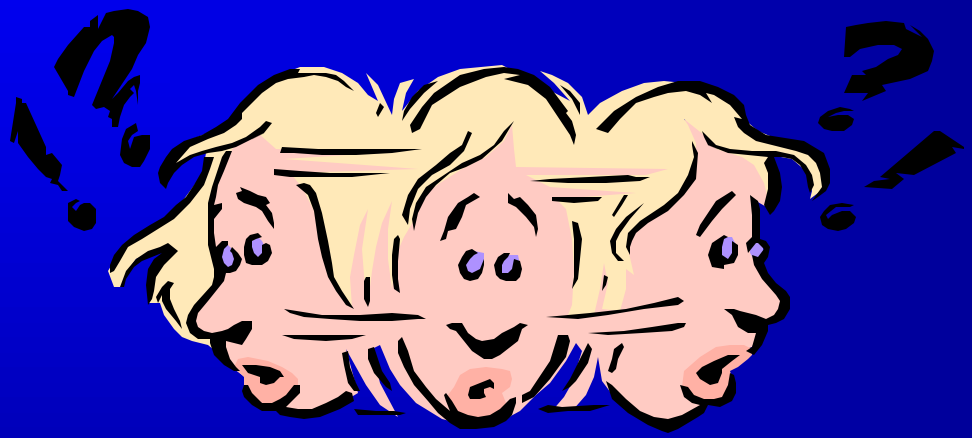
Desired End-State



- CG decision makers will have the tools needed to ensure our deployed cutters enjoy the same connectivity they have while inport.



Questions???



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